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Potential For Weather Modification In Alberta

Alberta
AGRICULTURE

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POTENTIAL FOR WEATHER MODIFICATION IN ALBERTA

A FIVE-YEAR STUDY

1980 - 1985

Report to the Minister of Agriculture

Government of Alberta

from the

Advisory Committee on Weather Modification

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Executive Summary

The programs of the Alberta Research Council supported by Alberta Agriculture have been foremost in weather modification research in Canada and the world. An operational hail suppression program financed by farmers through donations was initiated in Alberta in 1956. In 1973 the Government of Alberta, upon the recommendations of a Special MLA Committee, established the Interim Weather Modification Board (later named the Alberta Weather Modification Board) which was given a five-year mandate to conduct both a research and an operational hail suppression program and to evaluate these programs.

Following the recommendations of the Alberta Weather Modification Board in 1979 directives were issued by the Minister of Agriculture which led to the initiation of another five-year program in 1980. At this time, the Alberta Research Council replaced Alberta Agriculture as the manager of the programs. The Council continued its hailstorm research with gradual expansion into rain augmentation and mountain snow pack programs. An Advisory Committee, comprised of seven farmers, a representative from the University of Alberta and a representative from Alberta Agriculture was formed to advise the Minister of Agriculture and the Alberta Research Council on the development of weather modification for this program.

The major results and recommendations arising from the 1980-85 program are provided in the reports of the Alberta Research Council and in the body of this Advisory Committee report. Based upon these results, this Committee recommends that a five-year program be established in 1987 with a sixth interim year to allow further

evaluation and recommendations. The research program should continue studies on hail suppression with increased emphasis on rain augmentation and increase of snow in the headwater areas of Alberta rivers. The application of such research to an operational cloud seeding program from ground base or from aircraft should be carried forward. Recommendations on suggested administration and funding of the programs are outlined in this report.

Alberta has developed a world-wide reputation in weather modification and has the nucleus of scientists to further enhance this reputation. This report suggests that we should take advantage of this opportunity to make a major positive impact on agriculture and the many other industries influenced by weather. The economic assessment of such programs on loss to recovery (cost benefit ratio) in hail suppression and on the potential for drought control indicates a very high positive relationship.

AGRICULTURE Advisory Committee on Weather Modification 403/443-5503

Box 9
Three Hills, Alberta, Canada
T0M 2A0

October, 1986

Honorable Peter Elzinga,
Minister of Agriculture,
Honorable Shirley Cripps,
Associate Minister of Agriculture,
Room 324 Legislature Building,
EDMONTON, Alberta.
T5K 2B6

Dear Sir & Madam:

On behalf of the Advisory Committee, I am pleased to transmit our report on the five year study on weather modification, 1980 - 1985.

We are indebted to the Provincial Government for its foresight and support which has enabled Alberta to take a leading role in the field of weather modification. Our program is classed as one of the leading weather modification projects in the world and it is especially rewarding when one considers there are over 40 countries conducting weather modification programs.

It has been our privilege to work with the Alberta Research Council and Alberta Agriculture. With the rapid advances in instrumentation and new technology it has been a very exciting time to be involved.

The Advisory Committee has met monthly and has worked diligently to help give sound direction to the program. Some members have been privileged to attend weather modification conferences in and outside of Canada and have been able to discuss mutual concerns with scientists and operators involved in programs throughout the world.

Dr. Bernard Silverman, a noted Meteorologist and Head of the Bureau of Reclamation in the United States, says that weather modification has at least a ten to one cost-benefit ratio. He also suggests that we use what we now know and better our programs as we gain knowledge.

Based on the results of the past 5-year weather modification study as well as previous programs in Alberta and elsewhere, the Advisory Committee

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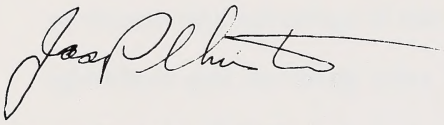
recommends that research be continued in hail suppression, rain augmentation and snowpack enhancement with increased emphasis being placed on rain augmentation and snowpack. We would also recommend that operational seeding for rain increase and hail suppression be continued with consideration being given to extending the current target areas.

The delivery of this report culminates our assignment on the five year study. Our Committee would be pleased to assist in any way we can to carry into action the recommendations contained in this report.

It has been a pleasure to serve on this Committee.

Yours very truly,



James Christie, Chairman
Advisory Committee on
Weather Modification

1. PREFACE

For farmers in Alberta, the arrival or absence of rain, hail or snow can mean the difference between prosperity and financial hardship, between a bumper year and a disaster. Today, the programs of the Alberta Research Council (ARC) supported by Alberta Agriculture are a driving force behind weather modification research and operations in Canada and in the world. These programs involve hail suppression, rainfall augmentation and snowpack enhancement. They are a continuation of weather modification studies which have gone forward in Alberta under various auspices since 1956.

The ARC has submitted a report on the success of their programs for the five year period from 1980 - 1985. The Advisory Committee on Weather Modification has advised the Minister of Agriculture and the ARC on these programs during this period. This report includes its evaluation of the research and operational components of the programs and of their potential economic impact on agriculture and other industries in the province. This report also includes the Committee's recommendations regarding future weather modification in the area of hail, rain and snow.

2. INTRODUCTION

(a) History of Weather Modification in Alberta

Hail losses in Alberta are among the highest in the world. Thus, it was not too surprising that a hail suppression program was discussed by a local of the Farmer's Union of Alberta in 1952. In 1955 the Kneehill Hail Suppression Association was formed. Eventually, as farmers in other Municipalities and Counties became interested, these locals federated into an overall Association under the Co-operative Societies Act and were known as the Alberta Weather Modification Co-operative (AWMC).

A hail suppression program, financed by farmers through donations, was initiated in Alberta on July 20, 1956. Later that year and in each ensuing year, the local County and/or Municipality collected money through a mill rate, provided that the majority of the eligible voters were in favour. I.P. Krick Associates of Canada were the cloud seeding contractors from July, 1956 through September 30, 1968. There were no hail suppression programs from 1969 to 1971 inclusive.

Scientists at the Alberta Research Council, known as the "Alberta Hail Studies Group", studied hail suppression techniques and did evaluation of same in the period from 1956 to 1973. They established a system of hail reporting by mail which was later supplemented by telephone. A Decca X-Band radar was installed at the then Royal Canadian Air Force Base, Penhold in 1957. The Hail Studies Group studied hailfall observations and related these to the radar storm tracks. An S-Band radar was

acquired in 1963 which gave better resolution of storm structure.

In 1973 the Government of Alberta, upon the recommendations of a Special MLA Committee, established the Interim Weather Modification Board (later named the Alberta Weather Modification Board) which was given a five year mandate to conduct both a research and an operational hail suppression program and to evaluate these programs. The weather modification program operated from 1974 to 1978 inclusive and continued for the interim year 1979 pending completion of the final report.

(b) Recommendations of the Alberta Weather Modification Board - 1979

In 1979, the Alberta Weather Modification Board, after considering the economic potential, results from crop insurance data, research and improved technologies, recommended the following:

1. That operational hail suppression programs be continued and that consideration be given to extending them beyond the current target boundaries;

2. That a Crown Corporation administer the programs with the Alberta Government financing the cost for the next five years with a view to farmers in protection areas eventually sharing costs; the majority of the Board of Directors should be farmers;

3. That a government-funded research program be continued to improve operational capabilities;

4. That an evaluation design be incorporated into the operational programs;

5. That a scientific advisory committee be appointed to advise the corporation on both research and operations;

6. That seeding operations and research be contracted to appropriate agencies;

7. That a Provincial Government department be empowered to issue permits and licenses for all cloud seeding activities in Alberta;

8. That a climatological study be undertaken to assess the potential for precipitation augmentation by area and identify the problems involved.

c) Directives from the Minister of Agriculture — Current 1980-85 Program

1. That the Research Council (ARC) is to replace Alberta Agriculture as the administrative overseer of the Weather Modification Program.

2. That a Board to advise the Minister will be retained.

3. That subcommittees be created to act as advisory bodies on the three major disciplines of the revised project; rain increase, snowpack improvement and hail suppression.

That two new elements be added:

a) A ground generator system east and south of Calgary.

b) Snowpack improvement in an attempt to increase snowfall in those areas that feed spring run-off on the eastern slopes.

4. That an aircraft cloud seeding operation will be continued in a 120-mile wide elongated area centred on Red Deer.

5. That funding is to come from the Department of Agriculture.

6. That a Chairman be a producer on the Board.

7. That ARC are to take full responsibility to run this program. However, the producers are to be given an opportunity to present their views.

(d) The Advisory Committee -Mandate and Membership

In 1980 another five year program was initiated, under the management of the Alberta Research Council. The Alberta Research Council replaced Alberta Agriculture as the manager of the weather modification programs. The Research Council continued its hailstorm research programs with gradual expansion into rain augmentation and mountain snow pack programs. An Advisory Committee (Appendix I), comprised of seven farmers, a representative from the University of Alberta and a representative from Alberta Agriculture, was formed to advise the Minister of Agriculture and the Alberta Research Council on the development of weather modification for this program.

(e) Economic Impact of Hail Suppression, Rain Augmentation and Snowpack Enhancement

Weather is the condition of the atmosphere in terms of heat, pressure, wind and moisture. Near the surface of the earth the atmosphere is dense and heavy. Here in the lower atmosphere we see the ever-changing, dramatic, often violent weather show. Adverse weather results in major economic losses of millions of dollars per year in

agriculture, forestry, transportation, recreation and other industries as well as influencing the life of the average individual.

Hailstorms inflict an average loss of $150 million dollars per year to crops in Alberta and can inflict major losses in urban centres, as for example the estimated loss of $125 million in Calgary in 1981. Losses in production associated with droughts such as that experienced in 1985 resulted in crop insurance payments of approximately $270 million which probably represented less than one-half of the actual loss.

Snow provides a major source of moisture reserves in Alberta. Control of snowpack, along with rain augmentation could have a major impact on both dryland and irrigation agriculture and also on Alberta's urban and industrial water users.

The economic impact studies conducted by the Production and Resource Economics Branch, Alberta Agriculture (personal communication) and the Alberta Research Council study suggest that:

a) the reduction of hail losses by 5 per cent would be cost effective;

b) rain enhancement could help to increase the overall average production and help reduce the severity of major drought when it occurs.

If an operational weather modification system was designed for Alberta, as outlined in the above study, in order for the system to break even, benefits equivalent to 6.5 per cent of present hail insurance premiums and administrative costs are sufficient to pay for the total cost of the system.

3. SUMMARY OF ALBERTA RESEARCH COUNCIL RECOMMENDATIONS

The major objectives of the five-year research and operations project were:

a) To assess whether cloud seeding sufficiently influences hailstorms to cause a change in hailfall;

b) To qualitatively assess the potential for increasing rainfall by seeding cumulus clouds in Alberta;

c) To determine the physical and economic feasibility of increasing snowfall in the Alberta Rocky Mountains by cloud seeding;

d) To evaluate the ability of ground-based generators to inject suitable amounts of ice-nucleating material into clouds;

e) To seed clouds for hail suppression using aircraft.

The following methods were employed in the research program:

a) An instrumented cloud physics aircraft and weather radar were used to look at changes produced within storms by cloud seeding. The cloud physics aircraft facility was developed jointly by INTERA Technologies and the Alberta Research Council.

b) Forecasting techniques were improved to provide methods to predict how storms behave and thus help to detect seeding effects and improve cloud seeding operations.

c) New observational techniques were investigated to provide measures that could be used in an evaluation of cloud seeding.

d) Various observational methods were used to determine the destination of various seeding materials from both ground and airborne delivery sources.

4. RESULTS AND RECOMMENDATIONS ARISING FROM THE 1980 - 1985 PROGRAM

The major results and recommendations arising from these research and operational studies were:

(a) Hail Suppression

1. A precipitation process chain has been developed to illustrate the sequence of events which lead to precipitation (hail) at the ground.

2. Several steps in the hailstone growth process have been investigated and results show that seeding hailstorms with silver iodide influences the hail growth process.

3. The volunteer hail system with about 23,000 observers has resulted in the largest collection of hail data in the world. A climatological time-distribution analysis of hail over the past 29 years has shown that hail can occur at all hours of the day in central Alberta.

4. A model of typical Alberta hailstorms has been developed and tested. Controlled seeding experiments have been conducted to evaluate the effect of cloud seeding on the hail growth process.

5. A basis has been obtained for developing statistical design and evaluation analysis of an optimal hail suppression experiment for Alberta.

6. Many important findings about the origin and evolution of hail have been obtained during the past five years but there are still questions that remain unanswered.

7. Results of these studies have given Alberta a world-wide reputation in hail suppression research. A spinoff effect has been the development of a substantial industry associated with hail suppression and the export of this industry to various countries in the world.

(b) Rain Augmentation

1. Experiments conducted during the past five years have shown that it is scientifically possible to make some clouds rain that would not rain naturally in Alberta. The results are the most convincing evidence that the world scientific community has yet seen that it is possible to make rain.

2. Ground-based silver iodide generators, with and without airborne support, have been in use for over 30 years. Attempts have been made to assess the efficacy of ground-based seeding systems through laboratory and field experiments.

3. The ice nucleating seeding agents which are used in Alberta have been characterized in the dynamic cloud chamber in Colorado State University and have been shown to be effective.

4. A study was undertaken with the assistance of the Atmospheric Environment Service to describe the occurrence of suitable cumulus clouds for rain augmentation in central and southern Alberta.

5. The potential impact of current technology on future research, operations and evaluation of hail suppression and rain augmentation is being studied.

(c) Snowpack Increase

1. Initial observations indicate that the potential exists to increase snowpack at higher elevations in the Canadian Rockies.

2. Field measurements have been made of the microphysical characteristics of winter clouds over the southern Canadian Rocky Mountains in addition to climatological studies of snowfall.

5. RECOMMENDATIONS

(a) Research and Operations

1. That a five-year program be established in 1987 with a sixth interim year to allow further evaluation and recommendations. Such an interim year with adequate funding is necessary to prevent loss of continuity.

2. That a continuing and increased research program be funded to determine the range of conditions under which rain can be increased through cloud seeding.

3. That a hail suppression research program be conducted to address the important issues of hail growth.

4. That ground generators, with and without supplemental seeding, be adequately evaluated to determine their place in an operational program.

5. That the application of such research on rain augmentation and hail suppression to an operational cloud seeding program from ground base or from aircraft should be carried forward.

6. That studies be conducted to determine the potential and practicality of applying techniques now available to increase snow in the headwater areas of Alberta rivers. Increased emphasis should be placed in this area with the intent of implementing an operational program.

7. That all future programs be subject to an ongoing review process. An evaluation design should be built into operational, as well as research programs.

(b) Administration and Funding

1. That consideration be given to extending the seeding operations beyond the current target areas with the ultimate aim of including the entire province, subject to agreement from the producers or others involved.

2.That consideration be given to extending the period over which programs operate, particularly for rain augmentation, where moisture is needed early in the season.

3. That a continuing emphasis be placed on weather forecasting in future programs.

4. That the research programs be funded by the Province of Alberta with the research to be under the supervision of the Alberta Research Council. As weather modification has a major impact on areas in addition to agriculture, consideration should be given to obtaining research support from other departments as well as Agriculture.

5. That a Board be constituted with a majority of its members as producers.

6. That consideration be given to cost-sharing of the operational rain augmentation and hail suppression programs in the protection areas.

7. That an approach be made to obtain financial support from the farming community, urban areas and industry which might be affected by weather.

8. That consideration be given to separating the operational from the research programs for hail suppression and rain augmentation. As co-ordination is required a strong link must be maintained between operational research components. There is a need to share resources to make the programs as cost effective as possible.

9. That support be given to hosting and assisting in the funding of Hailswath II in Alberta in 1988 as this international program will provide important supplemental information to the Alberta program.

6. CONCLUSIONS

The one aspect of weather modification about which no question remains is the issue of benefit. There is no doubt that, if perfected, weather modification in the areas of rain, hail or snow would result in tremendous advances, not only for the farming section, but for the province as a whole. Dudley Warner's comment that "Everybody talks about the weather, but nobody does anything about it" is no longer true. Man has yet to conquer the elements but the scientific understanding and advances in technology have combined to increase his odds in what was once a no-win contest.

The detailed recommendations in this report, based on the results of the past five-year weather modification program as well as previous programs in Alberta and elsewhere, are positive. It is recommended that research be continued in hail suppression, rain augmentation and snowpack enhancement with increased emphasis on rain augmentation and snowpack. Operational seeding for rain increase and hail suppression should continue with the general recommendation that these programs be extended beyond the current target areas.

Alberta has developed a world-wide reputation in weather modification and has the nucleus of scientists to further enhance this reputation. We should take advantage of this opportunity to make a major positive impact on agriculture and other industries and to broaden the economic base of the province.

ACKNOWLEDGEMENTS

We wish to thank the Alberta Research Council for its support and, in particular, Drs. E.A. Babcock, M. English, R.G. Humphries and Mr. J. Renick for their unlimited time and expertise which has greatly assisted in bringing about this report. We also wish to acknowledge Dr. Art Olson of Alberta Agriculture for his support and help in co-ordinating the research program. We are grateful to Dr. Carlyle Ross and Mr. Peter Woloshyn of the Economics Branch, Alberta Agriculture, for putting together a report on the effect of hail and drought on major crops in Alberta. A special thank you to Dr. John Bowland, Mr. James Christie and Mrs. Dorothy Stewart for their part in the preparation of this report.

REFERENCES

Alberta Research Council Report -Weather Modification in Alberta Final Report on Research and Operations 1980 - 1985

Alberta Hail Project - A Five Year Study 1974 - 1978, report to Alberta Agriculture, Government of Alberta from the Alberta Weather Modification Board July, 1979

Effect of Hail and Drought on Major Crops in Alberta, Production and Resource Economics Branch, Economic Services Division, Alberta Agriculture July, 1986

Report of the Special Committee on Crop Insurance and Weather Modification March, 1973

APPENDIX I

The Ministerial Order dated August 11, 1980 reads as follows:

The Advisory Committee on Weather Modification is hereby established to advise the Minister on all matters relating to the suppression of hail in the Province of Alberta, and appoint the following persons as members of this Committee to serve at the pleasure of the Minister.

James P. Christie, Farmer Trochu	Chairman
Robert W. Fisher, Farmer, Didsbury	Member
Leonard Haney, Farmer, Picture Butte	Member
Dr. J. P. Bowland, Dean of Agriculture and Forestry, University of Albreta	Member
Harold E. Howe, Farmer Swalwell	Member
Albert F. Wagner, Farmer, Lacombe	Member
W. Arthur Jones, Farmer, Vulcan	Member
Gordon Sterling, Civil Servant, Three Hills	Member
Dorothy Stewart, Civil Servant, Three Hills	Secretary

Dated 11 August, 1980

The Ministerial Order dated August 11, 1980 is amended by this order by deleting "Gordon Sterling, Civil Servant, Three Hills, Member" and by adding "Thomas Thurber, Farmer, Winfield, Member". Dated 5 May, 1981

The Ministerial Order dated August 11, 1980, as amended, is amended by deleting "Thomas Thurber, Farmer, Winfield, Member". Dated 22 January, 1985

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